PAP-832

PART III - ICE-PREVENTION SYSTEM

Introduction

Stress studies made on Ross Dam, for the stage with the crest at elevation 1582, took into account maximum flood and earthquake stresses but did not include iceload stresses. This followed the request of the Federal Power Commission that ice be prevented from forming in the vicinity of the spillway gates. In planning an ice-prevention system, it was believed advisable to not only prevent ice from forming in the vicinity of the spillways but also around the entire length of the arch.

Previous extensive investigations of an ice-prevention system for Grand Coulee Dam showed that the air-lift system was the most satisfactory. This system makes use of a series of nozzles on the upstream side of the dam, discharging air into the reservoir 10 feet or more below the surface. The resulting circulation bringing warmer water from below to the surface, prevents the formation of ice near the upstream face of the dam.

The design of the Grand Coulee system was based on tests made on a 1:1 scale model by the Bureau's Hydraulic Laboratory. From these tests, the type of nozzle, the direction of the air jet, the quantity of air necessary at each nozzle, the inside diameter and shape of the nozzle itself, the vertical spacing of the nozzles, and other details were determined. Using this and other data, the details of the Grand Coulee installation were prepared.

When an ice-prevention system for Ross Dam was suggested, the Hydraulic Laboratory was requested to make a preliminary investigation to determine the essentials of the system. During the winter season when freezing would occur, the reservoir will be between elevations 1500 and 1550. The ice-prevention system outlined in this report is similar to the Grand Coulee system and is designed to protect the entire arch from ice pressure with the reservoir above elevation 1500.

Preliminary Considerations

Much of the Grand Coulee Dam ice-prevention system may be adapted for use at Ross Dam. However, certain dissimilarities in the structures make it necessary to provide a different piping layout for the air supply. The lack of an inspection or operating gallery at a convenient elevation in Ross Dam introduces problems not present at Grand Coulee. Because of the thin arch section, it will not be feasible to construct a gallery in Ross Dam for the installation of compressors, pipes, and headers. Thus, it will be necessary to install the compressors at the roadway elevation, say, in one of the abutments, and run piping through the arch to the nozzles on the upstream face of the dam.

The thin arch section also introduces another problem in that during severe winter conditions, the temperature gradient from the front to the back of the dam may place the air supply pipes in a freezing zone. The piping should be located near the upstream face of the arch and arranged so that freezing of condensed moisture in the pipes be eliminated.

Proposed System

Design

Two horizontal rows of nozzles are considered necessary, the lower at elevation 1490 and the upper at elevation 1530. This should provide complete protection against formation of ice for reservoir elevations 1500 to 1550 and also for rare cases where the reservoir might be above elevation 1550 during the winter season. Two rows are necessary to prevent excessive pressures at the compressor.

From actual experience on Keokuk and other dams, it has been found desirable to place the nozzles between 10 and 12 feet apart, laterally, in each row. Thus, at Ross Dam, where winter conditions can be severe, the 10-foot spacing was necessary.

Assuming 1,000 feet of arch to be protected, there would be 100 nozzles in each row, or a total of 200 nozzles on the upstream face of the dam. If each nozzle discharges 2 cubic feet of free air per minute, this would make a total and maximum discharge of 200 cubic feet of free air per minute, since only one row of nozzles would be discharging at any one time. Air would be supplied by two compressors, each capable of handling 110 cubic feet of free air per minute. A third compressor, similar to the others, would be necessary as a standby unit and would be interconnected to the other two. It is suggested that these compressors be of the motor-driven air-cooled rotary type similar to those made by the Yeoman Manufacturing Company. Preliminary estimates indicate that the compressors be capable of maintaining a 40 pound per square inch gage pressure during operation of the system.

Figure 30 shows a schematic layout of a suggested installation for Ross Dam. Each of the two operating compressors discharges into a 4-inch header to which are connected four 1-1/4-inch copper distributing pipes, each serving approximately one-eighth of the arch. Each distribution pipe should serve about 12, and not more than 15, nozzles. The nozzles should be connected to the distributing pipes with 1/2-inch copper pipe.

Just below the header, each distributing line should be equipped with a regulating valve and a Bourdon-type gage. Cleanouts should be provided at each end of the distributing lines, in the header, and at each nozzle.

Effectiveness

Since no reliable data are at present available on air and water temperatures, it is not possible to predict accurately the effectiveness of the suggested system. However, based on weather conditions at Ross Dam as reported by a former resident of the area and from experiences at other dams, the suggested system should prevent the formation of ice for a distance of 10 feet upstream from the dam with intermittent operation of 4 hours on and 4 hours off, and be capable of removing 18 inches of ice with 8 hours of continuous operation.

Precautions

There are some precautions to be observed in completing the design of this system. Care should be taken to insure that no nozzle discharges appreciably more than 2 cubic feet of free air per minute. This is necessary to prevent freezing inside the nozzle and also to prevent unequal distribution to other nozzles on the same supply line. The Bourdon gage readings for various reservoir elevations should be calculated for each row of nozzles to insure the proper distribution and quantity of air. In brief, the system suggested here should be considered a preliminary proposal rather than a final design.

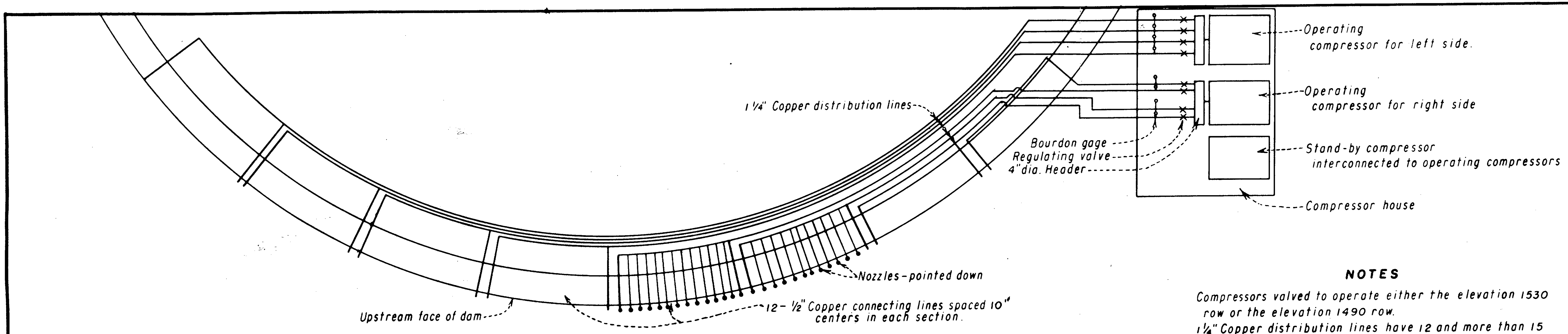
Figure 31 shows the general plan of the Grand Coulee installation, Figure 32 gives the operating diagram and instructions, Figure 33 indicates the type of air supply piping and the details of the nozzles, and Figure 34 lists the parts and sizes. These drawings should prove useful in completing the design of the Ross Dam ice-prevention system.

REFERENCES AND BIBLIOGRAPHY

The enclosed drawings, Figures 30 through 34, showing the installation at Grand Coulee Dam may be used as a guide in completing the design of the Ross Dam system.

The hydraulic laboratory tests on the system installed at Grand Coulee Dam are discussed in Hydraulic Laboratory Report No. 68. This report appears in another form as a paper by T. G. Owen in the Transactions of the A.S.M.E., April 1942, Volume 64, No. 3. Included with this paper is a discussion of the Grand Coulee system by P. J. Bier, who directed the mechanical design work.

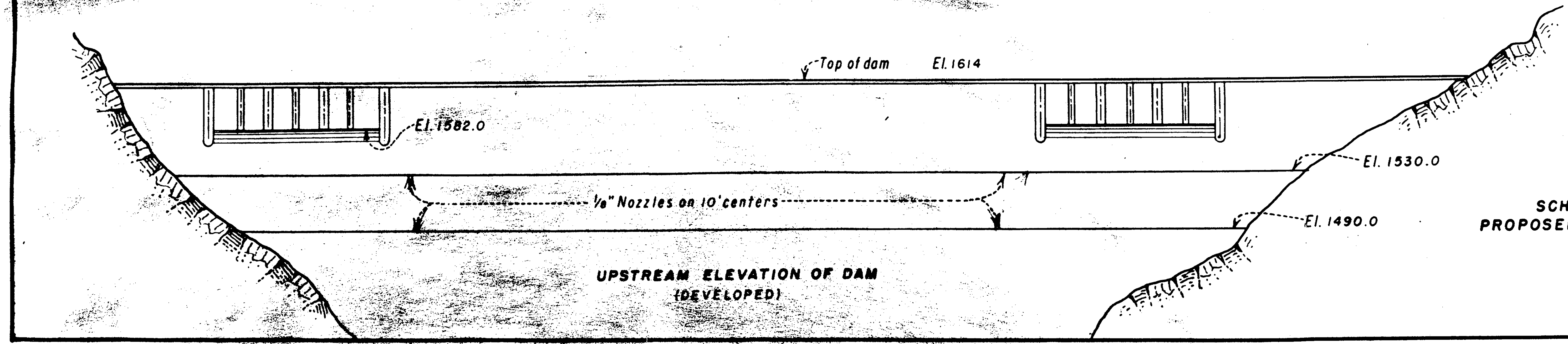
Another reference to the Grand Coulee system is contained in the Design Manual, tentative edition, "Penstock and Pipe Design Section of the Mechanical Division of the Branch of Design and Construction, Bureau of Reclamation."



PLAN

NOTES

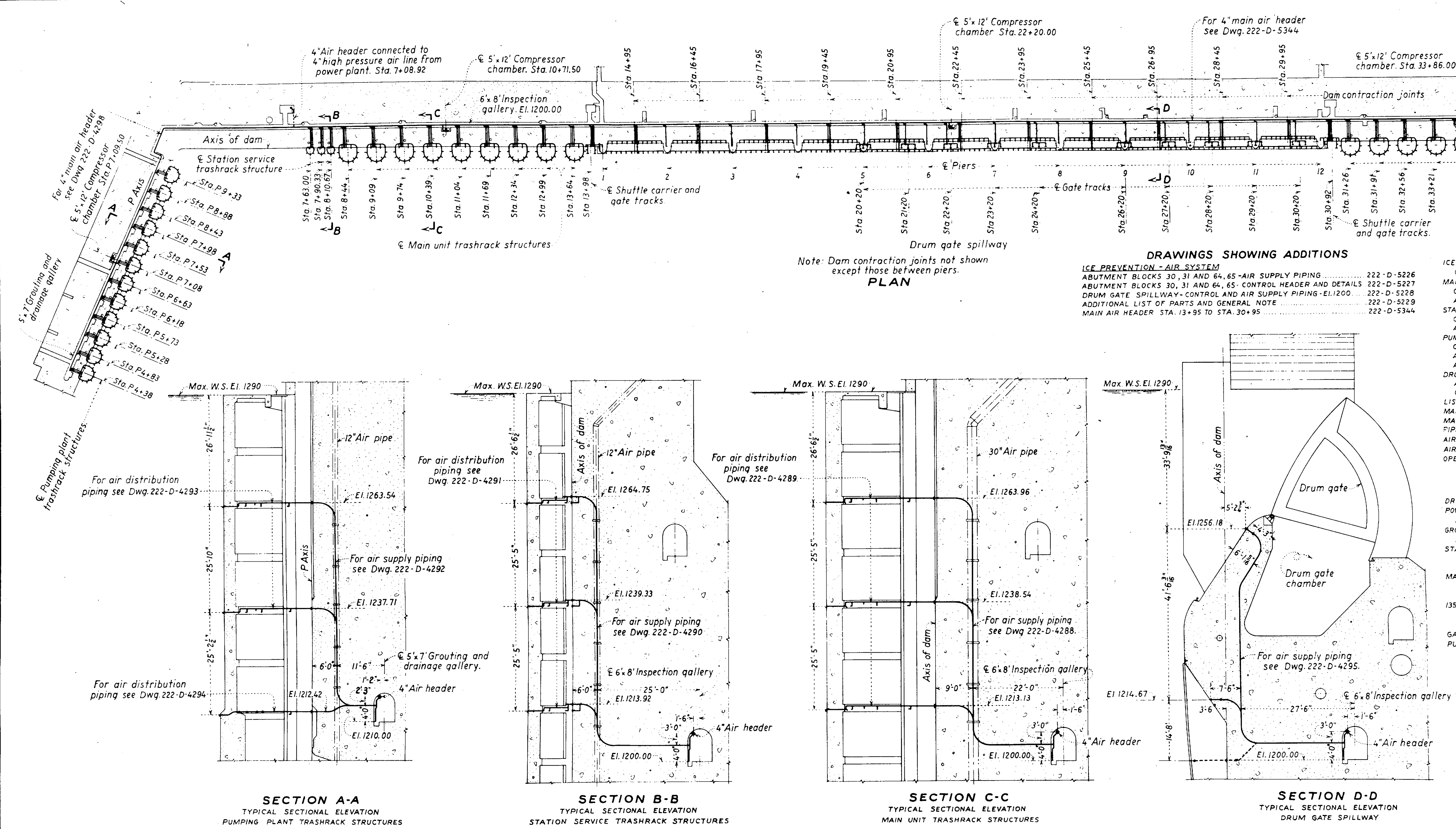
Compressors valved to operate either the elevation 1530 row or the elevation 1490 row.
1 1/4" Copper distribution lines have 12 and more than 15 nozzles per line.
Compressor – motor driven rotary-type, 110 Cu.ft. of free air per minute at 40 p.s.i gage press.
Provide cleanouts at ends of each nozzle and at end of each distribution line.



UPSTREAM ELEVATION OF DAM
(DEVELOPED)

ROSS DAM

SCHEMATIC DIAGRAM OF PROPOSED ICE PREVENTION SYSTEM



DRAWINGS SHOWING ADDITIONS

ICE PREVENTION - AIR SYSTEM

ABUTMENT BLOCKS 30, 31 AND 64, 65 - AIR SUPPLY PIPING	222-D-5226
ABUTMENT BLOCKS 30, 31 AND 64, 65 - CONTROL HEADER AND DETAILS	222-D-5227
DRUM GATE SPILLWAY - CONTROL AND AIR SUPPLY PIPING - EL. 1200	222-D-5228
ADDITIONAL LIST OF PARTS AND GENERAL NOTE	222-D-5229
MAIN AIR HEADER STA. 13+95 TO STA. 30+95	222-D-5344

LIST OF DRAWINGS

ICE PREVENTION - AIR SYSTEM	
GENERAL PLAN AND SECTIONS	222-D-4287
MAIN UNIT TRASHRACK STRUCTURES	
CONTROL AND AIR SUPPLY PIPING	222-D-4288
AIR DISTRIBUTION PIPING	222-D-4289
STATION SERVICE TRASHRACK STRUCTURES	
CONTROL AND AIR SUPPLY PIPING	222-D-4290
AIR DISTRIBUTION PIPING	222-D-4291
PUMPING PLANT TRASHRACK STRUCTURES	
CONTROL AND AIR SUPPLY PIPING	222-D-4292
AIR DISTRIBUTION PIPING	222-D-4293
AIR DISTRIBUTION PIPING	222-D-4294
DRUM GATE SPILLWAY	
AIR SUPPLY PIPING	222-D-4295
CONTROL HEADER AND DETAILS	222-D-4296
LIST OF PARTS AND GENERAL NOTE	222-D-4297
MAIN AIR HEADER - STA. P4+34.83 TO STA. 13+95	222-D-4298
MAIN AIR HEADER - STA. 30+95 TO STA. 37+80.50	222-D-4299
PIPE SUPPORTS AND CLAMPS	222-D-4300
AIR COMPRESSORS, PIPING ASSEMBLY, AND LIST OF PARTS	222-D-6301
AIR COMPRESSOR, PIPING ASSEMBLY, AND PIPE SUPPORTS	222-D-6302
OPERATING DIAGRAM AND INSTRUCTIONS	222-D-4303

REFERENCE DRAWINGS

DRUM GATE SPILLWAY - PLAN AND SECTIONS	222-D-1934
POWER AND STATION SERVICE PENSTOCKS - BY-PASS AND AIR PIPING	222-D-2125
GROUTING AND DRAINAGE GALLERY - PLAN AND ELEVATION. STA. P4+17 TO STA. 5+74	222-D-2172
STATION SERVICE	
TRASHRACK STRUCTURE	222-D-2215
TRASHRACK STRUCTURE REINFORCEMENT ABOVE EL. 1023.13	222-D-2217
MAIN UNITS	
TRASHRACK STRUCTURE ABOVE EL. 1061.25	222-D-2222
TRASHRACK STRUCTURE - REINFORCEMENT ABOVE EL. 1061.25	222-D-2313
135'x 28' DRUM GATE - EMBEDDED GATE ANCHORAGE	
ANCHOR BOLT LOCATION DIAGRAMS	222-D-2653
GATE CHAMBER CONTOUR - ANCHOR BOLT SETTING	222-D-2657
GALLERY AND SHAFT LAYOUT - PLAN - EL. 1200	222-D-2804
PUMPING PLANT	
TRASHRACK STRUCTURE BELOW EL. 1212.33	222-D-3100
TRASHRACK STRUCTURE ABOVE EL. 1212.33	222-D-3101
TRASHRACK STRUCTURE - REINFORCEMENT ABOVE EL. 1177.77	222-D-3105
BY-PASS AND AIR PIPING	222-D-3640
SHUTTLE CARRIAGE SUPPORTS - BLOCKS 30, 31 AND 64, 65	222-D-4947

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON

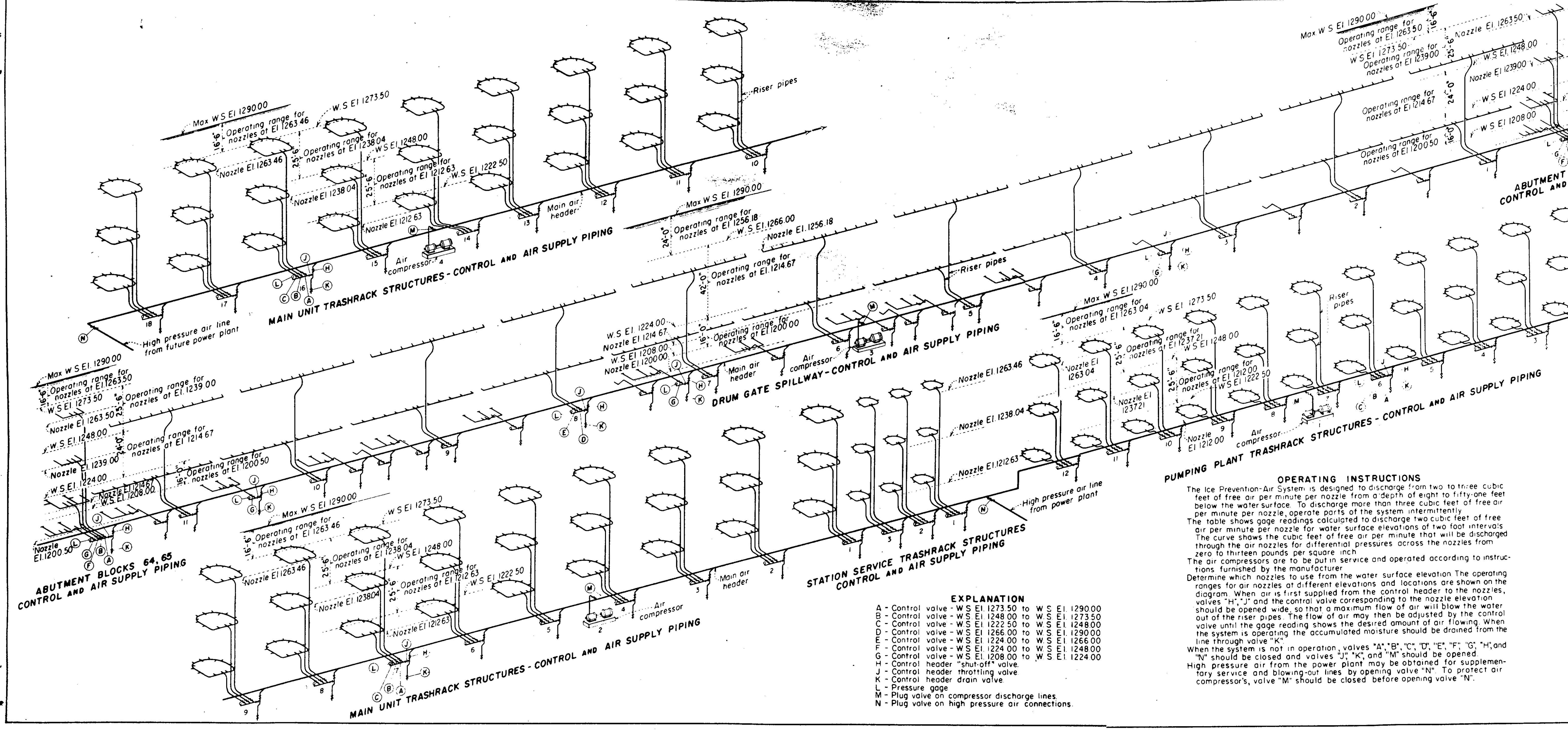
GRAND COULEE DAM
ICE PREVENTION - AIR SYSTEM
GENERAL PLAN AND SECTIONS

DRAWN: J.C.W. SUBMITTED: L.R. McClellan
TRACED: R.E.B. RECOMMENDED: [signature]
CHECKED: W.H.J. B. APPROVED: [signature]
DENVER, COLORADO, SEPT 25, 1939 SHEET 1 OF 1 222-D-4287

REV. 2-28-40 U.W.H. 8-13-40

HYD-207

FIGURE 32



OPERATING INSTRUCTIONS

The Ice Prevention-Air System is designed to discharge from two to three cubic feet of free air per minute per nozzle from a depth of eight to fifty-one feet below the water surface. To discharge more than three cubic feet of free air per minute per nozzle, operate parts of the system intermittently.

The table shows gage readings calculated to discharge two cubic feet of free air per minute per nozzle for water surface elevations of two foot intervals. The curve shows the cubic feet of free air per minute that will be discharged through the air nozzles for differential pressures across the nozzles from zero to thirteen pounds per square inch.

The air compressors are to be put in service and operated according to instructions furnished by the manufacturer.

Determine which nozzles to use from the water surface elevation. The operating ranges for air nozzles at different elevations and locations are shown on the diagram. When air is first supplied from the control header to the nozzles, valves "H", "J" and the control valve corresponding to the nozzle elevation should be opened wide, so that a maximum flow of air will blow the water out of the riser pipes. The flow of air may then be adjusted by the control valve until the gage reading shows the desired amount of air flowing. When the system is operating the accumulated moisture should be drained from the line through valve "K".

When the system is not in operation, valves "A", "B", "C", "D", "E", "F", "G", "H", and "N" should be closed and valves "J", "K", and "M" should be opened.

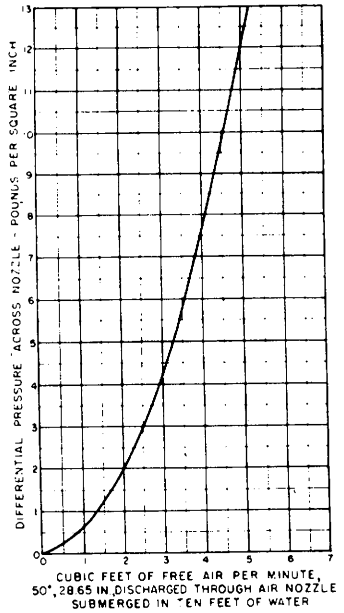
High pressure air from the power plant may be obtained for supplementary service and blowing-out lines by opening valve "N". To protect air compressor's, valve "M" should be closed before opening valve "N".

EXPLANATION

A - Control valve - W S El. 1273.50 to W S El. 1290.00
B - Control valve - W.S. El. 1248.00 to W.S. El. 1273.50
C - Control valve - W.S El. 1222.50 to W.S El. 1248.00
D - Control valve - W.S El 1266.00 to W.S. El. 1290.00
E - Control valve - W.S. El. 1224.00 to W.S El. 1266.00
F - Control valve - W.S El. 1224.00 to W.S El. 1248.00
G - Control valve - W.S. El. 1208.00 to W.S. El. 1224.00
H - Control header "shut-off" valve.
J - Control header throttling valve.
K - Control header drain valve.
L - Pressure gage
M - Plug valve on compressor discharge lines.
N - Plug valve on high pressure air connections.

TABLE

CALCULATED GAGE READINGS					
WATER SURFACE ELEVATION	MAIN UNIT TRASHRACK STRUCTURES	STATION SERVICE TRASHRACK STRUCTURES	PUMPING PLANT TRASHRACK STRUCTURES	DRUM GATE SPILLWAY	ABUTMENT BLOCKS 30,31, AND 64,65
1290	13.9	13.3	13.8	16.8	13.1
1288	13.1	12.5	13.0	16.0	12.3
1286	12.4	11.7	12.2	15.2	11.5
1284	11.6	10.9	11.4	14.4	10.7
1282	10.8	10.1	10.6	13.6	9.9
1280	10.0	9.3	9.8	12.8	9.1
1278	9.2	8.5	9.0	12.0	8.3
1276	8.4	7.7	8.2	11.3	7.5
1274	7.7	6.9	7.5	10.5	6.6
1272	16.7	16.3	16.8	9.7	15.8
1270	15.9	15.5	16.0	8.9	15.0
1268	15.2	14.7	15.2	8.1	14.1
1266	14.4	13.9	14.4	7.3	13.3
1264	13.6	13.0	13.6	23.0	12.5
1262	12.8	12.2	12.8	22.2	11.7
1260	12.0	11.4	12.0	21.4	10.9
1258	11.2	10.6	11.2	20.6	10.1
1256	10.4	9.8	10.4	19.8	9.3
1254	9.6	9.0	9.6	19.0	8.5
1252	8.8	8.2	8.8	18.2	7.6
1250	8.0	7.4	8.0	17.4	6.8
1248	7.2	6.6	7.2	16.5	6.0
1246	16.3	16.0	16.4	15.7	15.3
1244	15.5	15.2	15.6	14.9	14.5
1242	14.7	14.4	14.8	14.1	13.6
1240	13.9	13.5	14.0	13.3	12.8
1238	13.1	12.7	13.2	12.5	12.0
1236	12.3	11.9	12.4	11.7	11.2
1234	11.5	11.1	11.6	10.9	10.4
1232	10.7	10.3	10.7	10.1	9.6
1230	9.9	9.5	9.9	9.3	8.8
1228	9.1	8.7	9.1	8.5	8.0
1226	8.3	7.9	8.3	7.7	7.2
1224	7.6	7.1	7.5	6.9	6.4
1222	6.8	6.2	6.7	11.5	11.2
1220				10.7	10.4
1218				9.9	9.6
1216				9.1	8.7
1214				8.3	7.9
1212				7.5	7.1
1210				6.6	6.3
1208				5.8	5.5



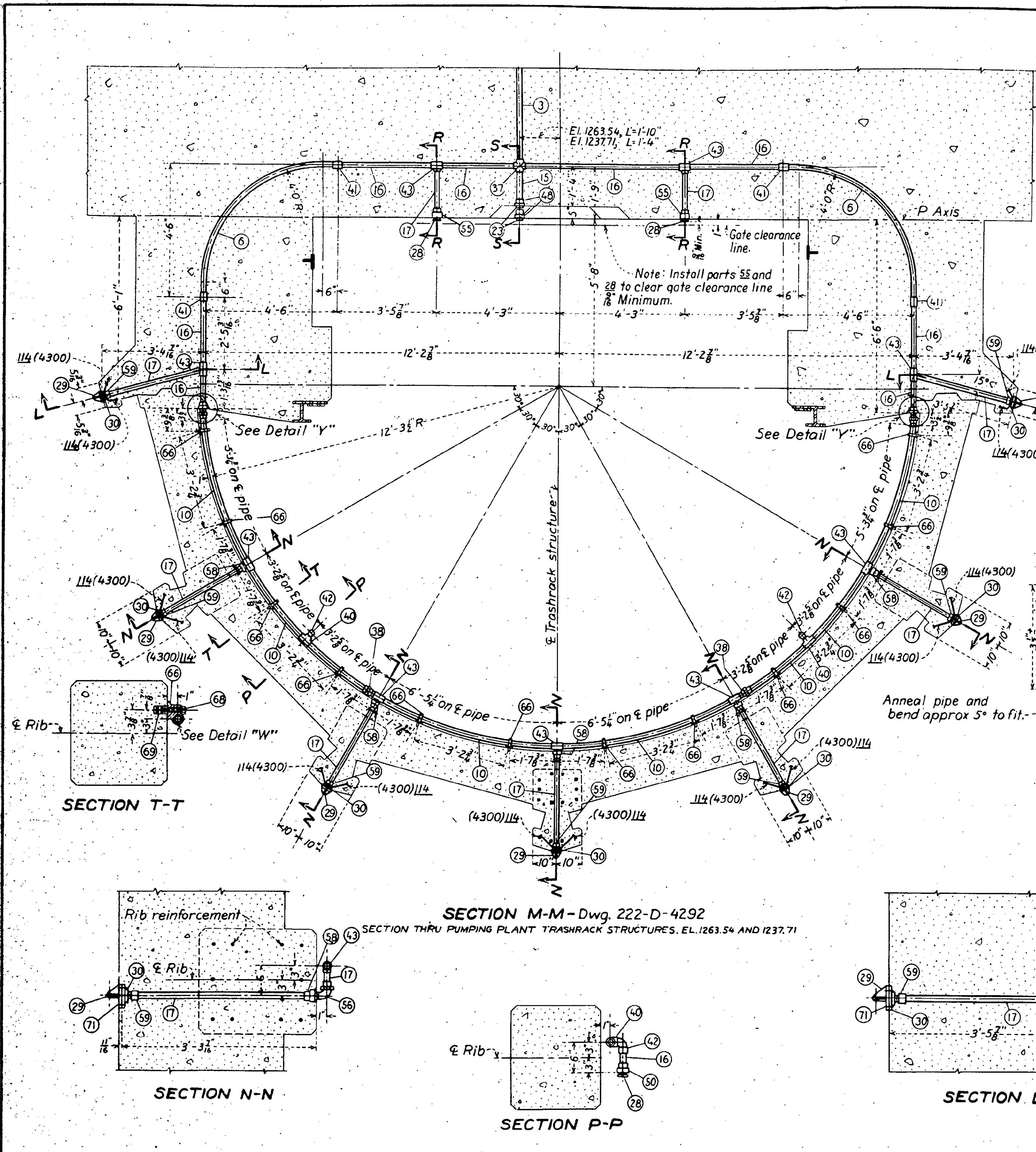
PRESSURE - DISCHARGE CURVE

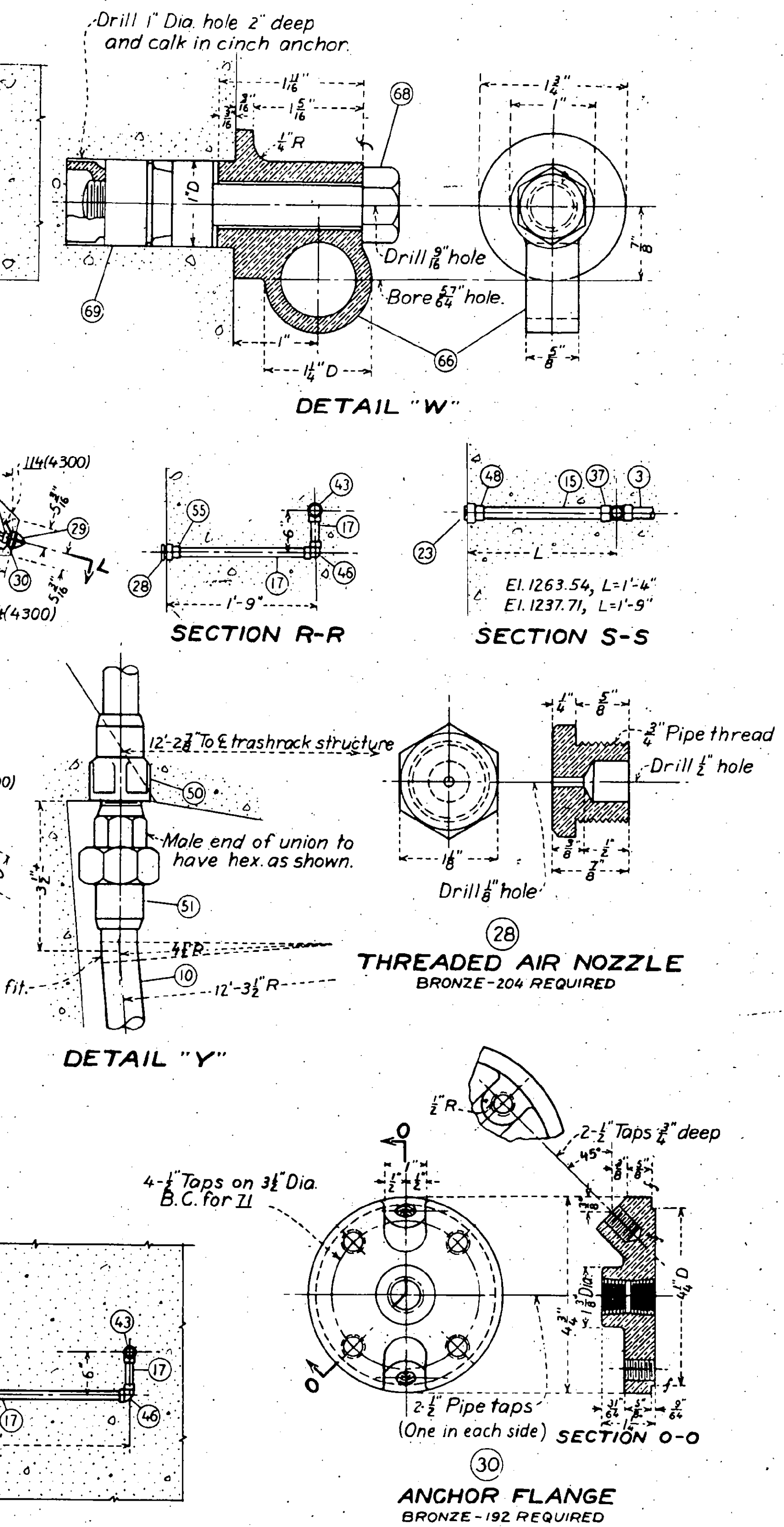
REFERENCE DRAWING
GENERAL PLAN AND SECTIONS 222-D-4287

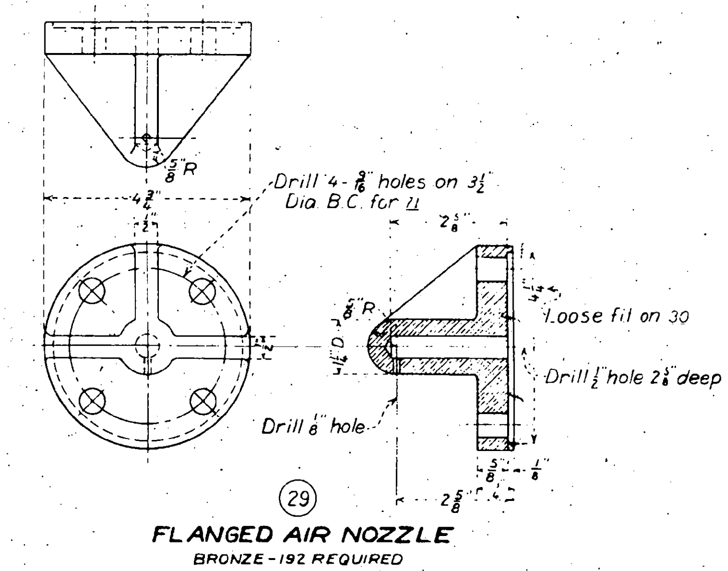
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON

GRAND COULEE DAM
ICE PREVENTION-AIR SYSTEM
OPERATING DIAGRAM AND INSTRUCTIONS

DRAWN J.C.W. SUBMITTED
TRACED R.E.B. - E.W.C. RECOMMENDED
CHECKED W.H.S. APPROVED
DENVER, COLORADO, NOV. 6, 1939. 222-D-4303







INSTALLATION NOTES

All pipe threads and flange faces shall be coated with a thin coat of red lead.

Before placing concrete close nozzle outlets with the countersunk plugs 25 or 33 and protect face of flange 30 so flange air nozzle 29 may be properly installed.

During concreting and pressure grouting maintain hydrostatic pressure in all embedded pipes as directed by the contracting officer.

After installation each unit of piping shall be air-tested at 50#/" internal pressure.

All exposed solder and threaded joints to be soap tested while the pipe is under air pressure.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON

GRAND COULEE DAM
ICE PREVENTION-AIR SYSTEM
PUMPING PLANT TRASHRACK STRUCTURE AIR DISTRIBUTION PIPING

DRAWN W.G.S. SUBMITTED
TRACED E.M.W. RECOMMENDED
CHECKED W.H.J. APPROVED

REV. 3-6-40

DENVER, COLORADO, SEPT. 25, 1939 SHEET 2 OF 3 222-D-4293

HYD-207

FIGURE 34

LIST OF PARTS

PART No.	DESCRIPTION	MATERIAL	MAIN UNIT TRASHRACK STRUCTURES		STATION SERVICE TRASHRACK STRUCTURES		PUMPING PLANT TRASHRACK STRUCTURES		DRUM GATE SPILLWAY		TOTAL QUANTITY REQ'D ON SUPPLY CONTRACT	PART No.
			QUANTITY	DWG. No. 222-D-	QUANTITY	DWG. No. 222-D-	QUANTITY	DWG. No. 222-D-	QUANTITY	DWG. No. 222-D-		
1	1" Pipe bend (detailed)	Copper	108	4288							108	1
2	1" Pipe bend (detailed)	Copper	3	4288							3	2
3	1" Pipe bend (detailed)	Copper			18	4290	48	4292	44	4296	110	3
4	1" Pipe bend (detailed)	Copper					12	4292			12	4
5	1" Pipe bend (detailed)	Copper							11	4296	11	5
6	3/4" Pipe bend	Copper	108	4289			72	4293			180	6
7	3/4" Pipe, 20'-0" lengths, bent to 16'-9" radius	Copper	135	4289							* 138	7
8	3/4" Pipe bend	Copper			18	4291					18	8
9	3/4" Pipe, 20'-0" lengths, bent to 5'-11" radius	Copper			9	4291					9	9
10	3/4" Pipe, 20'-0" lengths, bent to 12'-3 1/2" radius	Copper					44	4293			* 45	10
11	3/4" Pipe, 20'-0" lengths, bent to 12'-8 7/8" radius	Copper					23	4294			* 24	11
12	1/2" Pipe bend	Copper			18	4291					18	12
13	1/2" Pipe bend (detailed)	Copper					60	4294			60	13
14	1" Pipe. Std. I.P.S. random lengths, threaded and coupled	Brass	115 ft.	4288	20 ft.	4290	70 ft.	4292	70 ft.	4296	* 300 ft.	14
15	1" Pipe 20'-0" lengths	Copper	120	4288	21	4290	48	4292	52	4295	* 247	15
16	3/4" Pipe 20'-0" lengths	Copper	100	4289	7	4291	45	4293-94	142	4295	* 300	16
17	1/2" Pipe 20'-0" lengths	Copper	101	4289	6	4291	47	4293-94	26	4295	185	17
18	1"-45°-125# Elbow, screwed. I.P.S.	Bronze	54	4288	9	4290	36	4292	33	4296	* 138	18
19	1"-150# Union, screwed. I.P.S.	Bronze	36	4288	6	4290	24	4292	22	4296	* 92	19
20	1" Close nipple. Std. I.P.S.	Bronze	72	4288	12	4290	48	4292	44	4296	* 184	20
21	1"-125# Street tee, screwed. I.P.S.	Bronze	18	4288	3	4290	12	4292	11	4296	* 45	21
22	1"-125# Y type strainer, screwed. I.P.S.	Bronze	18	4288	3	4290	12	4292	11	4296	44	22
23	1" Countersunk plug. I.P.S.	Bronze	54	4289	9	4291	36	4293-94	22	4295	* 126	23
24	3/4" Countersunk plug. I.P.S.	Bronze			18	4291					* 20	24
25	3/4" Countersunk plug. I.P.S.	Bronze	270		9		204		264		765	25
26	3/4" x 1/2"-90°-125# Street elbow, screwed. I.P.S.	Bronze	54	4289							* 56	26
27	1/2" x 1/4" Bushing, screwed. I.P.S.	Bronze	18	4288	3	4290	12	4292	11	4296	* 45	27
28	Threaded air nozzle (detailed)	Bronze	270	4289	9	4291	204	4293	264	4296	* 765	28
29	Flanged air nozzle (detailed)	Bronze	378	4289	45	4291	192	4293			* 625	29
30	Anchor flange (detailed)	Bronze	378	4289	45	4291	192	4293			* 625	30
31	1" Pipe flange (detailed)	Bronze	54	4288	9	4290	36	4292	22	4296	* 125	31
32	1" Copper x 4 1/4" O.D. companion flange	Bronze	54	4288	9	4290	36	4292	22	4296	* 125	32
33	1/2" Countersunk plug. I.P.S.	Bronze	378		45		192				630	33
34	Tee, 1" copper x 1" copper x 1" copper	Bronze	54	4288	9	4290	36	4292	22	4296	* 125	34
35	Expansion joint, 1" copper x 1" copper	Bronze	27	4288	3	4290					* 31	35
36	Coupling, 1" copper x 1" copper	Bronze	264	4288	45	4290	132	4292	151	4295	* 610	36
37	Cross, 1" copper x 1" copper x 3/4" copper x 3/4" copper	Bronze	54	4289	9	4291	36	4293-94	22	4295	* 125	37
38	Union, 3/4" copper x 3/4" copper	Bronze	108	4289	9	4291	72	4293-94			* 195	38
39	Expansion joint, 3/4" copper x 3/4" copper	Bronze							66	4295	* 67	39
40	Tee, 3/4" copper x 3/4" copper x 3/4" copper	Bronze	108	4289	36	4291	48	4293			* 198	40
41	Coupling, 3/4" copper x 3/4" copper	Bronze	451	4289	52	4291	255	4293-94	142	4295	* 925	41
42	90° Elbow, 3/4" fitting x 3/4" copper	Bronze	108	4289			48	4293			* 162	42
43	Tee, 3/4" copper x 3/4" copper x 1/2" copper	Bronze	486	4289	36	4291	264	4293-94	220	4295	* 1025	43
44	90° Elbow, 3/4" copper x 1/2" copper	Bronze			18	4291			44	4295	* 64	44
45	Coupling, 1/2" copper x 1/2" copper	Bronze	101	4289	6	4291	47	4293-94	26	4295	* 194	45
46	90" Elbow, 1/2" copper x 1/2" copper	Bronze	216	4289	9	4291	144	4293-94			* 378	46
47	Coupling, 1" copper x 1" outside I.P.S.	Bronze	18	4288	3	4290	12	4292	11	4296	* 46	47
48	Coupling, 1" copper x 1" inside I.P.S.	Bronze	54	4289	9	4291	36	4293-94	22	4295	* 125	48
49	90° Elbow, 1" copper x 1/2" inside I.P.S.	Bronze	18	4288	3	4290	12	4292	11	4296	* 46	49
50	Coupling, 3/4" copper x 3/4" inside I.P.S.	Bronze	216	4289	36	4291	120	4293-94			* 382	50
51	Union, 3/4" copper x 3/4" outside I.P.S.	Bronze	108	4289			72	4293-94			* 185	51
52	90° Union elbow, 3/4" copper union end x 3/4" outside I.P.S.	Bronze			18	4291					* 19	52
53	Tee, 3/4" copper x 3/4" copper x 3/4" inside I.P.S.	Bronze					24	4294			* 25	53
54	Union tee (detailed)	Bronze					60	4294			* 62	54
55	Coupling, 1/2" copper x 3/4" inside I.P.S.	Bronze	108	4289	9	4291	132	4293-94	264	4295	* 525	55
56	90° Union elbaw, 1/2" copper union end x 1/2" outside I.P.S.	Bronze	216	4289	27	4291	120	4293			* 372	56
57	Unian tee, 1/2" outside I.P.S. x 1/2" inside I.P.S. x 1/2" copper union outlet	Bronze	54	4289							* 56	57
58	Coupling, 1/2" copper x 1/2" inside I.P.S.	Bronze	270	4289	27	4291	180	4293-94			* 488	58
59	Coupling, 1/2" copper x 1/2" outside I.P.S.	Bronze	378	4289	45	4291	192	4293-94			* 630	59
60	1"-150# Wedge disc gate valve, screwed. I.P.S.-R.S.	Brass	18	4288	3	4290	12	4292	11	4296	44	60
61	1"-150# Plug type disc globe valve, screwed. I.P.S.	Brass	36	4288	6	4290	24	4292	22	4296	88	61
62	150# Wedge disc gate valve, 1" copper x 1" copper. R.S.	Brass	54	4288	9	4290	36	4292	22	4296	121	62
63	Gage cock, tee head. 1/4" inside I.P.S. x 1/4" outside I.P.S.	Brass	18	4288	3	4290	12	4292	11	4296	44	63
64	Pressure gage	Brass	18	4288	3	4290	12	4292	11	4296	44	64
65	1" Pipe clamp (detailed)	Copper	36	4288	6	4290	24	4292	22	4296	* 90	65
66	3/4" Pipe support (detailed)	Bronze	648	4289	36	4291	432	4293			* 1140	66
67	3/8" Dia. x 2 1/2" long drive in stud type concrete anchor with hex. nut	Steel, galv.	72	4288	12	4290	48	4292	44	4296	* 180	67
68	1/2" Dia. x 3 1/4" long hex. head cap screw	Naval Brass	648	4289	36	4291	432	4293			* 1150	68
69	1/2"-2 Unit threaded cinch anchor. Phospher bronze male parts	Bronze, Lead	648	4289	36	4291	432	4293			* 1150	69
70	1/2" Dia. x 1" long hex. head cap screw	Naval Brass	216	4288	36	4290	144	4292	88	4296	* 510	70
71	1/2" Dia. x 1 3/8" long hex. head cap screw	Naval Brass	1512	4289	180	4291	768	4293-94			* 2510	71
72	Hair felt. 1" thick x 3'-0" wide		12 ft.	4288	2 ft.	4291			24 ft.	4295	* 40 ft.	72
73	Solder, 1/8" round wire. 5# spools (95% Tin and 5% Antimony)		15		2		8		5		* 30	73
74	Solder flux. 1# tins		9		1		5		3		* 20	74

GENERAL NOTE

All solder joint type of fittings shall be made of cast bronze alloy containing 85% copper, 5% tin, 5% zinc, and 5% lead. All joints indicated as copper connections are to be properly sized and finished for capillary type of solder joints. All joints indicated as iron pipe size connections shall have full clean-cut American Standard pipe threads. Companion flange 32 shall be plain faced with flange diameter, thickness, and drilling in accordance with M.S.S. 150 pound SP Bronze Flange Standard. All solder joint type of fittings to be air tested under water at 90#/a" gage pressure.

All iron pipe size fittings shall be 125# American Standard banded fittings made from cast bronze containing 85% copper, 5% tin, 5% zinc, and 5% lead. Threads shall be clean-cut American Standard type of pipe threads. All fittings shall be air tested under water at 125#/a" gage pressure.

All unions shall be of the ground joint type.

Threaded air nozzle, flanged air nozzle, anchor flange, 1" pipe flange, and 3/4" pipe support; part numbers 28, 29, 30, 31 and 66 respectively, shall be made of cast bronze alloy containing 85% copper, 5% tin, 5% zinc, and 5% lead.

All copper pipe shall be type "K", hard copper, and conform to Federal Specification WW-T-799 and be furnished in length specified. All bends to be made up complete by manufacturer. A light anneal of the pipe for making the bends will be permitted, so that the bending will return the pipe to it's approximate initial hardness.

All Standard iron pipe size brass pipe shall conform to the requirements for grade "A" water pipe as prescribed in Federal Specification WW-P-351 and be furnished semi-annealed. Pipe to be furnished in random lengths, threaded and coupled.

All cap screws shall be hex. head semi-finished naval brass cap screws with U.S. Standard threads.

Parts shall be marked or tagged with drawing numbers and part numbers, thus: 4289-27, 4291-27, 4293 & 94-27, etc.

* Total quantities listed include excess for loss or damage of parts by the field.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON

GRAND COULEE DAM

ICE PREVENTION – AIR SYSTEM

LIST OF PARTS AND GENERAL NOTE

DRAWN J.C.W. SUBMITTED L. N. McClellan
TRACED F.C.-R.L.A. RECOMMENDED J. L. Savage
CHECKED W.H.S. P.B. APPROVED
DENVER, COLORADO. SEPTEMBER 25, 1939 — 222-D-4297

REV 12-6-39 O.S. — 3-6-1940 W.H.S.